VOLUME 34, NO.1 • THE GEORGE WASHINGTON UNIVERSITY • EDITION 2, SPRING 1987

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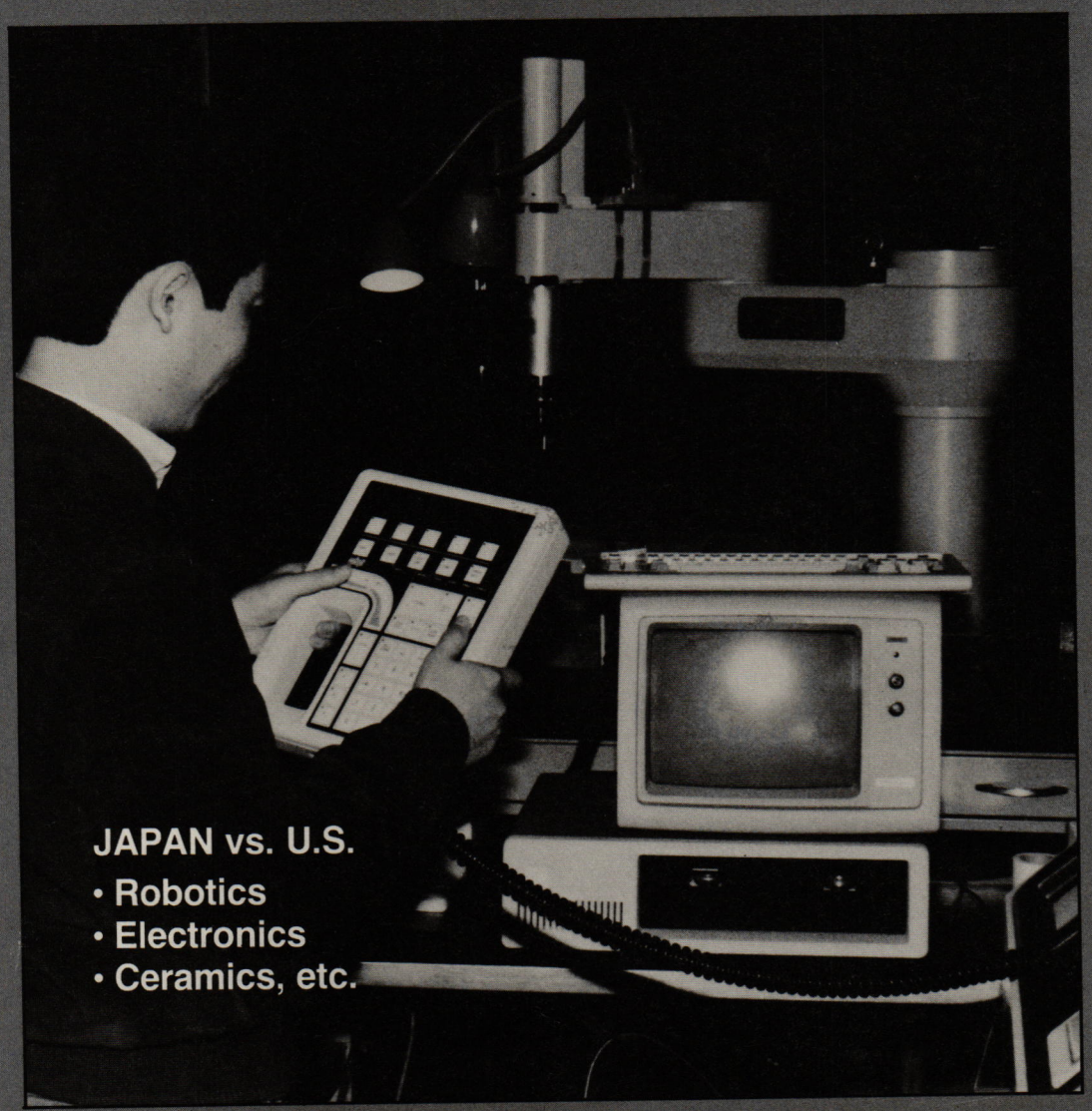

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Japan Trade Advantage Threatens US Competitiveness

by Jeff Winbourne

Japanese economic rising powers has brought to US attention the need to rethink their economic strategies. Trade deficits; the declining value of the dollar and clearance in industrial productivity all signify how US is sliding from the top and making the way for Japan. Will they ever regain their strength and rise above Japan?

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Tomorrow's Robots — Will They Read "Made in Japan" or "Made in USA?"

by Lilimar Z. Avelino & Swati Patel

Two industrial leaders - the US and Japan - attempt to maximize production levels and present imaginative ideas through factory automation. No form of automation can be without robots, machine tools or people. So, in their quest to produce high quality goods, both powers aim for implementation and improvement in factory automation.

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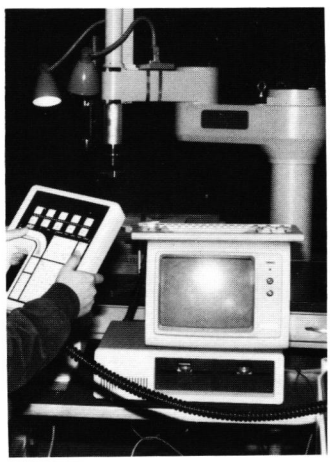

COVER: Manufacturing automation is one of the "hot" topics in Japan-U.S. technical competition. GWU has entered the fray with its new ADEPT II Robot, now sitting in Tompkins Hall. Photo by Euler V. Uy.

"We Don't Need No Education"; Are American Schools Coming Up Short?

by Rose Province

Can Americans imagine going to school for six days a week for 11 months in a year? While Americans are soaking in the sun, Japan is governing creativity and ingenuity through rigorous educational training. This scheme seems to be the key, since we now see the rising star, threatening US economic power, in Japan.

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Purchase of ADEPT Machine Strengthens GWU's Robotics Program

by Armen A. Sahagian

Did you know that George Washington University is harboring a robot in our own backyard? Well, open your eyes toward Tompkins Hall. Since robots are the stepping stone to automation, any technological implementation of GW's "mean machine" will improve our future's industrial outlook.

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US and Japan Battle for Dominance in Ceramics

by Beatrice Kovel

The ceramics industry is important for automotive and IC advances. As of late, Japan is winning the ceramics race. Can the US regain its lead in the ceramics industry, or is its dominance slipping through its fingers?

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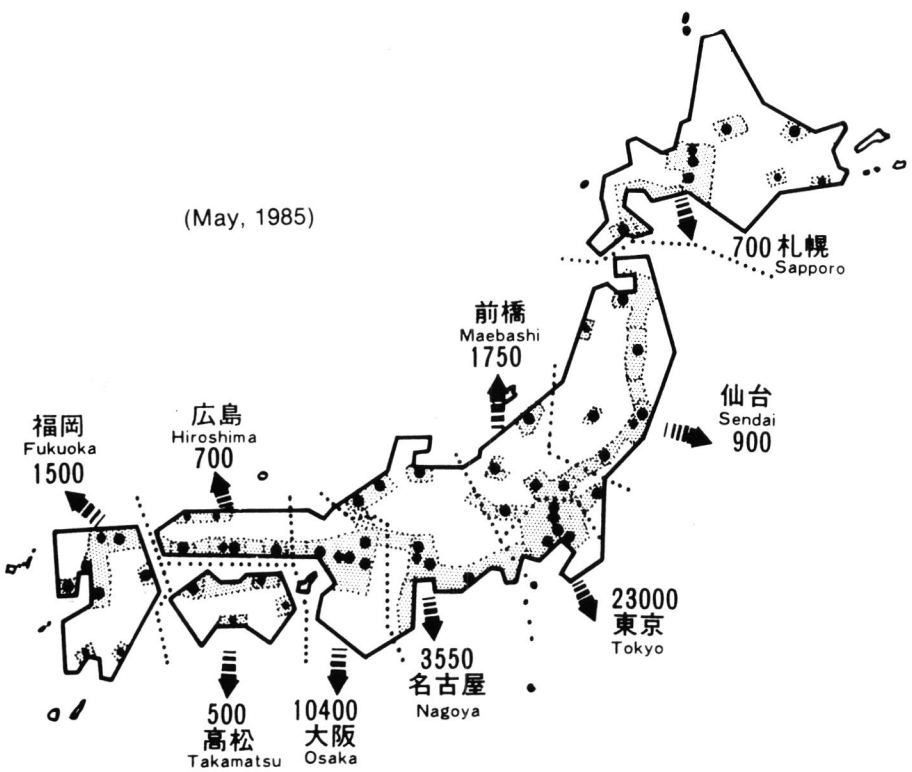


Development of a new, high-capacity, land-mobile telephone system is under way in Japan, The shaded area of this map represents the geographical zones that will be serviced by the system. Courtesy of IEEE Communications Magazine.

Japanese Leap for Lead in Mobile Phone Technology

IN the same way that our thirst for knowledge had helped us to advance from the first generation of computers to the present-day, third generation, silicon-chip computers, our ever-expanding need and demand for even more advanced technology have prompted NTT (Nippon Telegraph and Telephone) of Japan to begin research and development of a new, high-capacity land-mobile telephone system. This system is expected to replace the first generation of cellular land mobile telephone systems.

The current system, an 800 MHz-band land mobile telephone, first introduced in December, 1979, is currently servicing 43,000 subscribers in 51 areas. The capacity of subscribers, however, is expected to increase greatly with the application of the new system, since it will have upgraded services and lower rates, due to the expected lower system construction cost.

To develop the proposed system, some major techniques, such as narrow-band transmission, diversity reception, inter/intra-zone channel reassignment, adaptive transmitter power control, and flexible channel reassignment, will be used.

In using diversity reception, NTT hopes to reduce the carrier-to-noise ratio (CNR), enabling the introduction of upgraded detachable/portable mobile subscriber sets, as well as reduce the carrier-to-interference ratio (CIR), enabling high-density, geographical cochannel reuse. To improve the cochannel reuse efficiency under the bell-shaped traffic distribution conditions in Japan, the number of zones in a reuse cluster area must be reduced. To accomplish this, two other methods, beside diversity reception, may be used: evasion of speech quality degradation by detecting increased interference and reassigning a radio channel with less interference; and reduction of interference level by adaptive transmitter power control that keeps the receiving level a minimum.

With the objectives mentioned above in mind, NTT is continuously and intensively striving to realize the proposed system, which will have a spectral efficiency five times that of the present system. NTT hopes to have the new system ready and introduced in 1987-1988 by overlapping the existing system in the Tokyo area.

—Dieu Nguyen

●●

Japanese Follow Americans in Area of Reinforced Plastic

"They just don't make them the way they used to", may soon come to have a whole new meaning. The new building block of the future just might be plastic: reinforced plastic, that is.

Reinforced plastic is a general term for materials combining lightweight, non-corroding resin with fibers, which are either woven or else chopped into tiny fragments. Higher-performance RPs called **composites** are commonly based on tough durable resins, such as epoxies and phenolic, reinforced with fibers of carbon, silicon nitride or various

Continued on page **20**

Japan Trade Advantage Threatens U.S. Competitiveness

by Jeff Winbourne

ONE of the most hotly debated issues of the 1980's has been the growing U.S. trade deficit. This measure of our economic production soared to $175 billion in 1986, of which about $50 billion is with Japan. What has caused this to happen to the U.S., the world's largest economy? What are some of the repercussions to our economy? Will we ever get back to on top?

Since about 1981, when the deficits began piling up, there have been numerous solutions put forward. These have ranged from out and out protectionism of our national markets to penalties against trading partners thought to be dealing in unfair practices. Recently, talk of regaining our competitive edge in the world market has resurfaced with remarks by President Reagan in his State of the Union Address.

All the time out trade deficit was growing, millions of American workers have been laid off and the midwestern industrial heartland, "the arsenal of democracy," has been renamed the "rust belt," for its rusting factories. Who's fault is it that this tragedy has befallen our industry and its workers? Some want to blame the Japanese for underselling our goods. Others say that U.S. business have become complacent and the slogan "Made in The U.S.A" no longer had its "ring of quality" to the rest of the world.

JAPAN'S ROAD TO ECONOMIC POWER

It has taken the Japanese only about twenty-five years to become a major world economic power after World War II. This same accomplishment took the U.S. and the Europeans nearly 100 years to reach. This incredibly fast growth was due to many factors. One of the most important was Japanese trade policy.

During the 1950's and 60's and into the mid 70's Japan strongly protected its markets. The development of the economy was closely supervised by the government through the Finance Ministry and the International Ministry of Trade. Then, due to increased pressure from international trading partners, many of their trade restrictions were dropped.

THEN in the early 1980's, a number of new factors came into play. During the recession of 1981 to 1982, the dollar became highly overvalued. Making American-made goods become more expensive. Interest rates in the U.S. took off, hitting 20 percent. Investments in new equipment plummeted.

But Japan was less affected by this recession. Japanese suppliers with higher investment and inventory levels were ready to step in as the recovery began in the U.S., in 1983 and 1984. The high dollar exchange rate made imports much more attractive in U.S. markets and likewise undercut American competitiveness in foreign markets.

Interestingly, the last of major restrictions in the Japanese market place were lifted by the early 80's. And today, except for agricultural goods the Japanese have no formal legal barriers. So why haven't U.S. firms made headway into the Japanese markets?

"The Japanese market place is the most highly competitive in the world," according to Peter Lauter, Professor of International Business

The U.S. trade deficit is growing fast, as this table shows, with Japan tipping the scales. Courtesy of Business Week.

When was the last time your boss gave you a cooking lesson? A Vice President of Sanyo is doing just that in Forest City, Ark., in an effort to promote cultural understanding between American's and Japanese. Courtesy of Business Week.

at GWU, "and this is true for new domestic companies as well as foreign ones."

"There is a sense of quality of service, dedication to competition in that country that we simply can not cope with," Lauter continued. An example he pointed out was, cars are sold door-to-door in Japan. When you want your car serviced, an employee of the dealership comes to your house to pick the automobile up in the morning and returns it in the evening service, washed, and waxed! These practices are not government controlled but, "are an example of historical, cultural, social, and traditional factors which have existed for centuries."

The investment needed by a new company, domestic or foreign, to open business in Japan is quite high as a result. So, the combination of high investment and operating cost of setting up such a service-oriented operation, which will take years to be accepted as reliable, has put off many foreign investors.

Although this too is changing, "Tokyo's continuing liberalization of goods and services markets is beginning to have an impact on the level of foreign direct investment in Japan, according to a new report by the Japan Economic Institute. Finance Ministry figures for 1985 indicate that foreigners poured nearly twice as much capital as the year before in to new and existing Japanese enterprises."(Japan Economic Survey, Nov.,86).

The same journal also pointed out, "While virtually all legal barriers to foreign investment were dismantled a decade ago, only the advent of financial market liberalization has the infrastructure to support foreign investment begun to develop."

Another factor in the Japanese economy, which restricts new business ventures, is its distribution system. This system, which is primarily made up of "mom and pop" type operators, stresses a high degree of loyalty to old suppliers and customers making it hard for new outfits to break in. This sector of economy employs around 20 percent of the working population and has considerable political clout.

One of the reasons,for example, Japanese machine tool manufacturers have been limited in their ability to set up shops in other countries is because of their dependence on this network.The machine tool companies are heavily dependent on an intricate network of subcontractors whose prices and quality they can quite easily control.

Requests from our government, on behalf of U.S. companies, to the Japanese government to change the system, suggests asking for government intervention to get the distributors to, "drop your old suppliers and buy from me." The way this is seen by many Japanese, according to Lauter, is," by demanding you open up your markets we are really saying change, become different people, change your culture, change your tradition."

CALLS FOR PROTECTIONISM

Ever since the first trade deficits began to accumulate there have been calls for protectionists legislation from many quarters. The shoe and textile industries have asked for them for years in order to keep a share of the domestic U.S. market. Automobile manufacturers have demanded that Japanese car imports be restricted; steel producers have demanded the same thing. The unions have backed these demands in order to save members jobs. Members of Congress from the most affected states routinely look for political mileage by making statements in favor of keeping out those imports that are hurting their constituents. Such calls make great rallying cries, but what are the consequences we must face?

First, let's look at how governments define balance of trade. The balance of trade is measured solely by counting up imports on one side and exports on the other. This does not include services, or production of say U.S. companies in Japan and what they sell in Japan. Also not included is the considerable expenditure on the part of the United States military in maintaining bases in Japan, as well as the salaries of U.S. servicemen spent on consumer items in Japan.

"The balance of trade measure in incomplete, insufficient, and misleading. It does not truly present the problem," says Prof. Lauter, who is co-author of a book entitled, "The Internationalization of the Japanese Economy," with a member of the Japanese Diet, Dr. Chikara Higashi. "It is the traditional measure, but games can be played with it. This doesn't mean the problem is not severe. But it's less severe than a $175

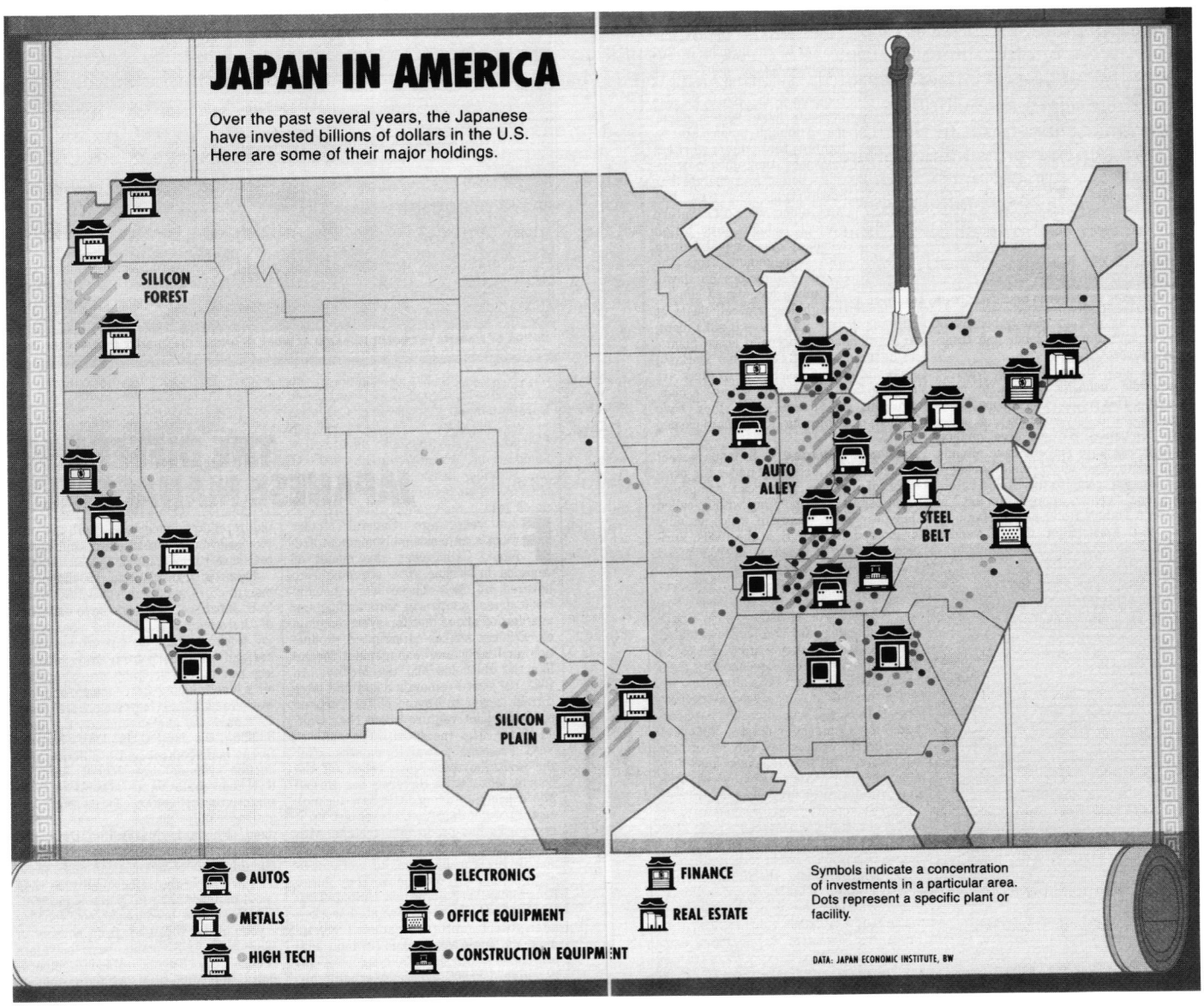
billion dollar imbalance with a $51.3 billion dollar Japanese component."

In July of 1985, the U.S. Senate considered legislation that would have urged the President to take retaliatory measures against Japan, if the Japanese did not eliminate any existing trade barriers. Later that year the Congress considered placing a 25 percent surcharge on Japanese imports.

The Japanese response was made by Prime Minister Nakasone, himself. He placed the trade issue on the level of the highest national priority and personally appealed to the Japanese people for support in resolving it.

If in response to this imbalance the U.S. government decided to retaliate against its trade partners what would be the response? According to Lauter, a number of things would happen. "There of course would be retaliation from our trading partners back at us. So our ability to trade would also be inhibited. Second, it would not help U.S. industry in the long run, although it might solve some short-term problems. Legislation of this nature generally doesn't include any measures to improve competitiveness." By holding back on import competition there would be nothing to spur on American companies to improve their products or services.

Lauter went on to point out some of the responsibilities the U.S. economy has in the world marketplace. "Even with all its problems, he size of the U.S. economy makes it second to none. The world economy goes the way of the U.S. economy. No one else has a three *trillion* dollar gross National Product(GNP)." He continued, "the dollar is the reserve currency of most of the world. Sixty percent of the reserves of most countries are in dollars. It is the main trading currency. If the U.S. went protectionist it would throw a wrench in the world economy." He went on to point out the effect such a scenario would would have on the Latin American countries, that are heavily in debt." Since the


JAPAN IN AMERICA
Over the past several years, the Japanese have invested billions of dollars in the U.S. Here are some of their major holdings.
SILICON FOREST
AUTO ALLEY
STEEL BELT
SILICON PLAIN
AUTOS
METALS
HIGH TECH
ELECTRONICS
OFFICE EQUIPMENT
CONSTRUCTION EQUIPMENT
FINANCE
REAL ESTATE
Symbols indicate a concentration of investments in a particular area. Dots represent a specific plant or facility.
DATA: JAPAN ECONOMIC INSTITUTE, BW

Japanese industry has make itself felt, not only from across the ocean, but with investments right here in the U.S, representing a number of areas. Courtesy of Business Week.

U.S. is the largest trading partner of many of these countries, not being able to trade with the U.S., would greatly diminish their ability to pay their debts to international an U.S. banks. That would have a devastating effect on the world economy."

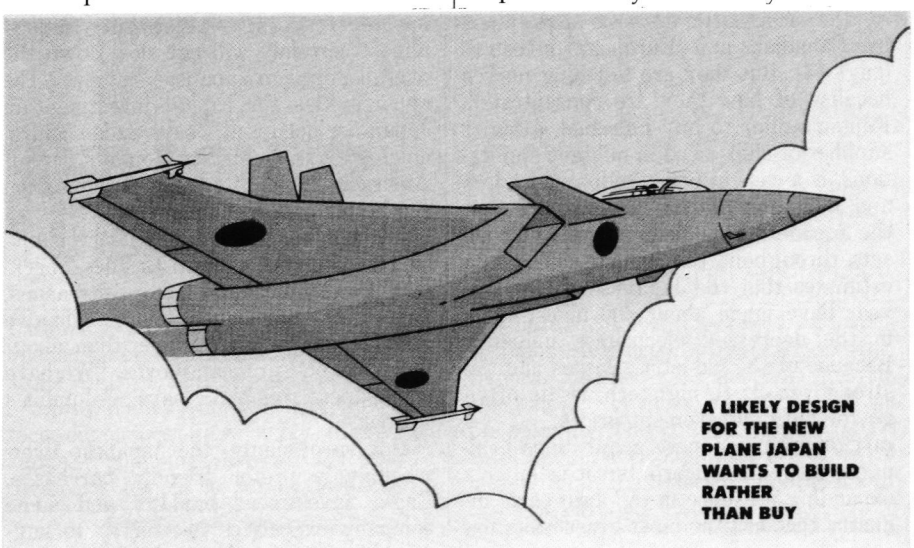
WHICH WAY OUT?

Both the United States and Japan are rethinking their trade strategies to cope with this situation.

A few years ago the Nakasone government set up a commission later referred to as the Maekqwa Commission. Its job was to study this situation, as well as Japan's new international position, and make recommendations. Its recommendations, released last May, were briefly, the following. First, Japan and its citizens should see themselves as a world economic power and in this light assume the responsibilities of one. This was opposed to the widely held view among Japanese that they were still a small struggling country. Second, the commission's main recommendation was that during the next ten years Japan should shift from an export lead trade policy to a policy of domestic demand lead growth. The idea is to raise the standard of living of the average Japanese citizen whom has not benefited from the countries massive growth and subsequent wealth. That the profits made from trade would be invested in higher salaries, increased housing production, and other non-industrial sectors rather than being reinvested in the manufacturing-trade base, which was the previous policy. Another recommendation was to reduce the last vestige of the past protectionist policy-agricultural import restrictions.

The recent slide in the value of the dollar has Japan's their ability to carry this out. Japanese trade is returning less money with the upward swing the yen has experienced. This will have an adverse effect on the U.S. -Japan Trade imbalance. Since the Japanese we beginning to cut down on their reinvestment in trade and some traditional industries such as coal mining and steel, it would have left room for the U.S. to gain back some of its lost ground.

In the U.S., there is increased talk about regaining our competitive edge. President Reagan mentioned such a proposal in his State of the Union message. The idea behind increasing competitiveness is essentially increasing productivity. This should be measured both from the standpoint of labor and the standpoint of capital investment. Both components are necessary to improve a nations productivity level. On a scale with the other major industrial nations, the United States ranks *last* in productivity from the years from 1975 to 1984.



Watch out, General Dynamics! The next generation of planes for the Japanese Air Force, the FSXs, is going to be designed and built in Japan. Courtesy of Business Week.

HOW did this happen? One reason was insufficient capital investment in new machines, automating our factories, and buying other new equipment. Another is the high cost of labor in relation to its productivity level as compared to foreign workers. Top-heavy management, i.e. too many layers of management, is another obstacle. The salaries of American managers are quite high when compared to Japanese counterparts. The president of Toyota or Honda makes in the range of $100,000 a year while the chairman of GM makes close to a million even in bad years.

Retooling our industry is a major factor in raising our ability to compete. The U.S. machine tool industry, an important basic industry, has been very slow to modernize. "Currently, the United States lags behind both Japan and Europe in installation and application of Flexible Manufacturing System, FMS, units; maintains a lead in Computer Aided Design, CAD, but lags in the application of Computer Aided Manufacturing, CAM." (Competitive Assessment of the U.S. Metal Working Machine Tool Industry; Report to the U.S. International Trade Commission; 9/83)

The same report points out the level of government sponsored research into this work. The Japanese Government provides grants and loans for research and development and also provides tax incentives for companies with strong R&D. This is in addition to the governments own supported research facilities. On the other hand, the U.S. has no such tax programs, and its only sponsored projects that are specifically to benefit nondefense production are with the Air Force and the National Bureau of Standards.

CASE STUDY: US MACHINE TOOL INDUSTRY LAGS BEHIND

Currently the United States is the second biggest supplier of machine tools in the world, behind Japan. Yet, U.S. made standard

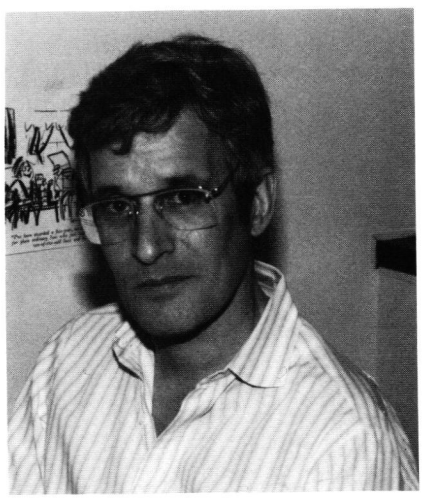
machine tools are considered more expensive, and of poorer quality, than their Japanese counterparts. The U.S. is still considered the best builders of specialty machines, such as those used in aerospace and transportation industries.

What has held back the move to modernize and automate our industry, besides the lack of major government effort? First, cost. The "got to make a bigger profit this quarter" or "I only care about the bottom line" syndrome of American industry, did not and still doesn't recognize that the large investment now will actually lower costs in the future. The idea of many of these automated systems is to reduce the use of direct labor in the manufacturing process, while at the same time, increase quality and speed delivery. Second, the attitude of many American managers toward Computer Integrated Manufacturing Systems (CIM), has been that "the system will itself be so smart and adaptable that it will be able to compensate for any problems." The Japanese, however, in designing their systems, have done so with competition in mind. Their systems can work on a large variety of parts anywhere from 20 to several hundred. American systems can only handle between 7 and about 70 different parts," according to Bruce Kramer , Professor of Computer Integrated Manufacturing at GWU. He went on to add that "the major difference are in philosophy and orientation. The Japanese have a more realistic attitude toward what it takes to make a system work: going from concept to product and giving people working on design problems the time to solve them. In a couple of words, the Japanese *believe* in CIM, they have sort of a fearless attitude toward it, i.e. if you invest in CIM it will be good for your company. Yet in the U.S., in the environment of cost justification it is very hard to justify the initial cash outlay."

CORPORATE RAIDERS SAP COMPETITIVENESS

As if American industry didn't have enough problems, new ones have emerged. One of the most dangerous to our ability to regain a competitive status has been the onslaught of corporate takeovers. Successful or unsuccessful, these attempts force the top management of corporations to focus on the attempted raid and spend millions in fighting it off. This money and effort is sorely needed to retool and modernize industry and enhance our trading position.

"The Japanese market place is the most highly competitive in the world.", according to Peter Lauter, Professor of International Business at GWU.



EULER V. UY

Professor Kramer,a GWU professor and an expert in Computer Integrated Manufacturing(CIM), believes philosophy and orientation create major differences in American and Japanese computer systems.

Senator John Heinz (R-Pa.), recently criticized this spread of takeovers at the Senate Finance Committee's first hearings into this matter. "Corporate managers can't worry about competing with the Japanese if they're busy competing with Wall Streeters for market shares in their own companies." Heinz added, "managers ought to be concerned about competitiveness, not fending off some quick-buck takeover artist."

Another important issue has been the declining value of the dollar. In the last month the dollar has dropped in value in relation to most of the world currencies. Its effect has been, on the one hand, to bring a more favorable position to American exports but, on the other, could be detrimental to the whole process of easing the trade balance with Japan. Specifically, it could hold the Japanese back from their goal of changing the focus of their economy to be more domestic-oriented. The need for capital to carry this through may force them to change this plan, even temporarily. Also, if the dollar continues to slide, a lack of confidence may develop among foreign investors, in general. The effect this would have could be seen in two ways: in the Stock Market and in the sale of U.S. government bonds to foreign investors.

One of the reasons the stock market is running at all-time highs is the increased investment by foreign traders. For example, much of the money made here by Japanese corporations is sent back to Japan and then reinvested in the U.S. stock markets. Second, almost a third of the budget deficit is financed by Japanese banks investing capital in U.S. government bonds. With a continued slide in the dollar, they would have less money to invest here. Furthermore, the question of confidence as to how this government is dealing with its responsibilities to the rest of the world economy will arise. Japanese and other foreign investors may begin looking for new investments outside of the U.S.

This is obviously a very complex issue that will be with us for quite some time to come. Whatever legislation the Congress passes will hopefully be well rounded, taking into account these and many other factors. ■

Tomorrow's Robots— 'Made in Japan'

by Lilimar Z. Avelino and Swati Patel

IN a world of growing competition, how does America stack up to Japan? The United States is still one of the richest, most powerful nations in existence—innovative in creating her policies, acknowledged around the world for her technical advances, research capabilities, and free-enterprise system,and praised for her loyal aid and sensitivity to other unfortunate countries.

Japan, on the other hand, is one of the fastest growing industrialized nations. A combination of fear, respect, and awe has been earned by a country whose history is as remarkable as its present achievements. A nation with half the population of the United States occupies an area about the size of the state of Montana; yet, can "stand up to the big guys." Although Japan imports most of its raw materials, it has one of he highest literacy rates and school attendance rates, as well as one of the lowest crime rates among the developed countries.

So how has a success story of this sort come about for Japan? The envious hypothesize that it is the concurrence of low-wage rates, willingness to stress applications at the expense of novelty, and centuries of tradition that have enlightened docility and loyalty to the population. Admirers say that it is a mixture of realistic appraisals, exemplary discipline, and imaginative policies. With such strong accomplishments, it is no wonder why the rest of the world uses Japan's ideals as a template in improving their own economic and technological societies. The latter is perhaps the field from which the United States and Japan attempt to accomplish the most.

For both nations, advances in factory automation are given top priority. The reason for this is that automation can help reduce expenses,save time, and eliminate tedious or hazardous tasks. It also should serve to maximize production levels and facilitate the introduction of newer, more imaginative ideas. **Factory automation** requires widespread use of robots, computers, and machine tools. Japan and the U.S. have their own ideas on how to approach this new developing field of interest.

Robots may not be human, but they do make mistakes. This is why these robot-assembled typewriters undergo manual testing by these Japanese women at Brother's plant in Nagoya. Courtesy of High Technology.

FACTORY AUTOMATION - SHOULD IT BE MADE "SIMPLE" OR "FLEXIBLE"?

Japan has the ability to produce high quality goods at a low cost by using the concept of simplicity. For example, Hitachi rates engineering designs with a score, based on how easy the design will be to assemble. As leaders in the auto industry, Japan continually attempts to increase flexibility in their assembly lines, reduce operation costs, and react quickly to the market demands.

In the attempts to catch up with Japan, U.S. concentrates on a flexible automation called **flexible manufacturing systems**, or FMS. Here, a central computer sequentially directs parts across each machine or robot until the

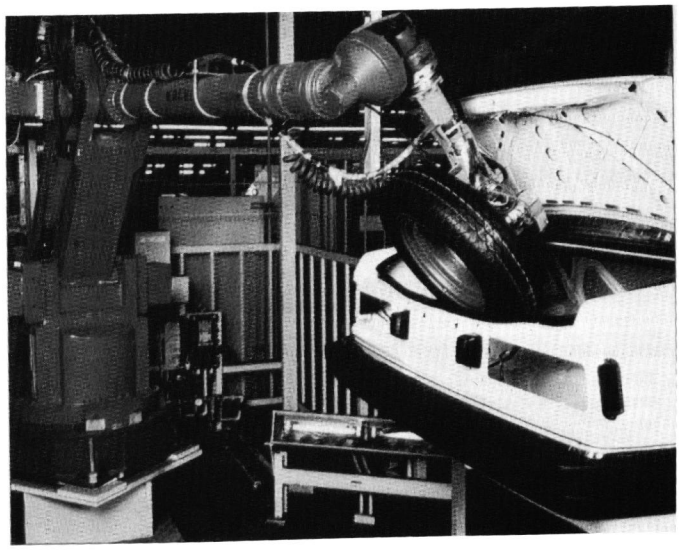
Will They Read or 'Made in USA'?

product is complete. Unfortunately, now it seems that FMS is really not as flexible as originally anticipated. For example, the large-scale FMS of Electro-optical and Data Systems Group of Hughes Aircraft took three years to debug. Also, parts often have to be manually checked and positioned, thus producing a tedious system for building products in the factory environment.

So, rather than the large-scale FMS, small growing companies have resorted to the reduced versions of FMS, better known as **flexible manufacturing cells**. For this version, a small-scale computer monitors the whole process. This cell concept breaks down the whole mechanism into minute parts and simplifies the system. Of course, the cells are designed for later attachment to a larger system. This requires communication interfaces in the central computer and automatic machine configuring so that material-handling systems can be added on. Therefore, flexible systems, although limited, utilize machinery more efficiently and reduce direct labor costs.

CAN ROBOTS CONQUER OUR INDUSTRIES?

A main contributor to factory automation, especially in Japan, is the robot. According to the Robotic Industries Association, Japan leads in the robot race with 200,000 robots (as of August, 1986), while the U.S. lags far behind with only 20,000 robots. In both the U.S. and Japan, robots perform repetitive jobs such as painting,and serving drinks. Robots are also advantageous for tasks hazardous to human health and safety, like welding and drilling. Both countries' ideas on the importance and uses of robots differ considerably; the Japanese stress mobility while the Americans concentrate on predictability.



Never have a spare tire when you need it? What you want is a robot like Nissan's, specially designed to do simple but arduous tasks, such as putting in a spare tire, or installing a battery. Courtesy of High Technology.

Most factory robots are blind and often perform the same movements, but Japan can easily reprogram their robots' motions in order to produce many different movements, so as to further maximize a variety of new products; therefore, Japan primarily utilizes robots for their adaptability and flexibility.

Observing the success of Japan with robots, the U.S. tried to catch up in the race, only to find out that robots were not the pivotal technology for them. To the U.S., robots are valuable for their predictability; i.e., knowing approximately how many products the robot makes at a given time and reducing extra cost for any leftover parts. As a result, U.S. robots are just computer-controlled machines that serve up materials for other equipment to work on.

THE JAPANESE APPROACH— "MAKE OUR OWN ROBOTS"

Another difference between Japan and the U.S. when it comes to robots in factory automation is how each country obtains their robots. The Japanese method is for each company to design, make and install their own robots and automation systems. This concept comes from the notion that each company knows their own products and are therefore the best qualified to automate their own factories. This goes back to the idea of simplicity, since most of Japan's robots lack the expensive and complex technology that vendors add for the general market. Thus, factories do not get any unwanted, expensive features in their robots.

In addition to designing their own robots, some Japanese companies have also redesigned their parts for easier handling by robots. For example, Brother Industries redesigned their whole typewriter so that their robots could access the parts easier without having to go under or around another part.

IN contrast to the simplistic Japanese approach of each company making its own robots and corresponding parts,

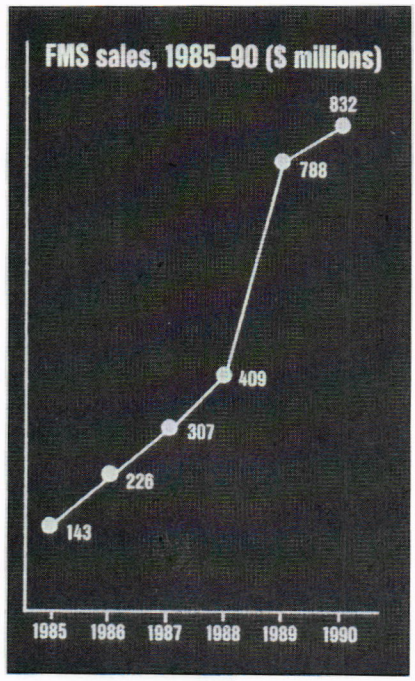
the U.S. approach requires purchasing their robots and other factory equipment from the commercial vendor. With this concept, the U.S. ran into several problems with reliability. Industry does not have a standard for robot speed, strength and repeatability; therefore, vendors have sold some robots with weak arms, and poor circuit design, and in some instances software bugs led to unexpected problems in controlling robotic movements.

In order to alleviate these problems, test facilities have been made for ensuring safer, more reliable U.S. robots. For instance, corporations like Chrysler have screening procedures to test robots before releasing them to the factory. Meanwhile, the Industrial Technology Institute, an independent test facility, is concentrating on testing robots according to very strict rules, and then supplying the results to commercial vendors. This system is designed to made manufacturers feel much safer about robot purchasing and installation.

ROBOTS ON ASSEMBLY LINES—HENRY FORD WOULD BE ASTONISHED

In both Japan and the U.S., robots are used extensively in the assembly line. For instance, Japan's Seiko/Epson corporation utilizes robots with hand sensors for gripping the small parts with good precision. Their "pileup" watch design and assembly is monitored by a central computer that automatically suspends the whole operation when it spots a problem, thus, avoiding a pileup. As a result, the robot assembly line creates a new watch per hour, and in doing so has doubled, in sheer numbers, the production of the Seiko/Epson Corporation.

Similarly, the U.S. IBM plant uses robots in an automated assembly. Work is passed from one robot to another, rather than having a single robot dedicated to assembling the whole product. Since each robot performs a single, simple task, a person can easily fill in when an assembly robot malfunctions. So, the assembly line procedure proves to be advantageous for both Japan and the U.S.



Sales of Flexible Manufacturing Systems (FMSs) should soar to more than 800 million dollars by 1990. Courtesy of High Technology.

Despite their similarities in making use of the assembly line procedure, Japan has taken advantage of the robot's programmability, while U.S. has not. This industry allowed Japan to create a mixture of different variations of a product, based on only a few basic models. According to market demands, Japan can change its products quickly, if necessary, as well as make those year-to-year model changes without retooling or shutting down the whole plant.

As opposed to the Japanese method of taking advantage of a robot's reprogrammability, U.S. robots are bolted to the floor with a single function, performing the same movements day after day. The automobile industry,for example reprograms once a year only to modify the robot for the new year's model! Whenever programming is necessary, it is done manually; i.e., an operator moves the robot arm through its motions, while a computer records the movements and plays them back at the appropriate time. Unlike the Japanese method, this requires a complete production shutdown.

ROBOTS . . . CAN THEY SUBSTITUTE FOR OUR WORKERS?

With all this talk of machines and robots in the process of factory automation, what happens to all the workers? Japanese workers have a high work involvement. Frequent suggestions for continual improvement on job comfort and product quality come from workers. Some companies, such as Seiko, give workers bonuses for workable ideas, while others post and recognize the best performers of the month. This also provides for healthy competition among workers.

Even with advances in automation, Japanese workers are not thrown into the streets, since many Japanese companies hire for life. Competent production workers are retrained, or transferred to another company facility, where manual work still exists. The finishing touches and concluding judgments on the final product are still formulated only from human workers. Thus, the need for these men never ceases to exist. With content employees, work stoppages due to industrial disputes are very rare in Japan.

INCREASING AUTOMATION CAUSES AMERICAN UNEMPLOYMENT

Unlike Japan, U.S. factories often end up replacing people's jobs with machines, resulting in unemployment for those individuals. We also hear instances of strikes in many industries. Yet, the U.S. is learning from Japan. Although American companies do not hire for life, corporations are now appreciating people as an important element in any automation system.

WHAT LIES AHEAD FOR AUTOMATION?

Japan and the U.S. do agree that more developments on the robot can improve its performance, precision and accuracy in a factory. New vision systems allow a robot

Continued on page **20**

"We Don't Need No Education"; Are American Schools Coming Up Short?

by Rose Province

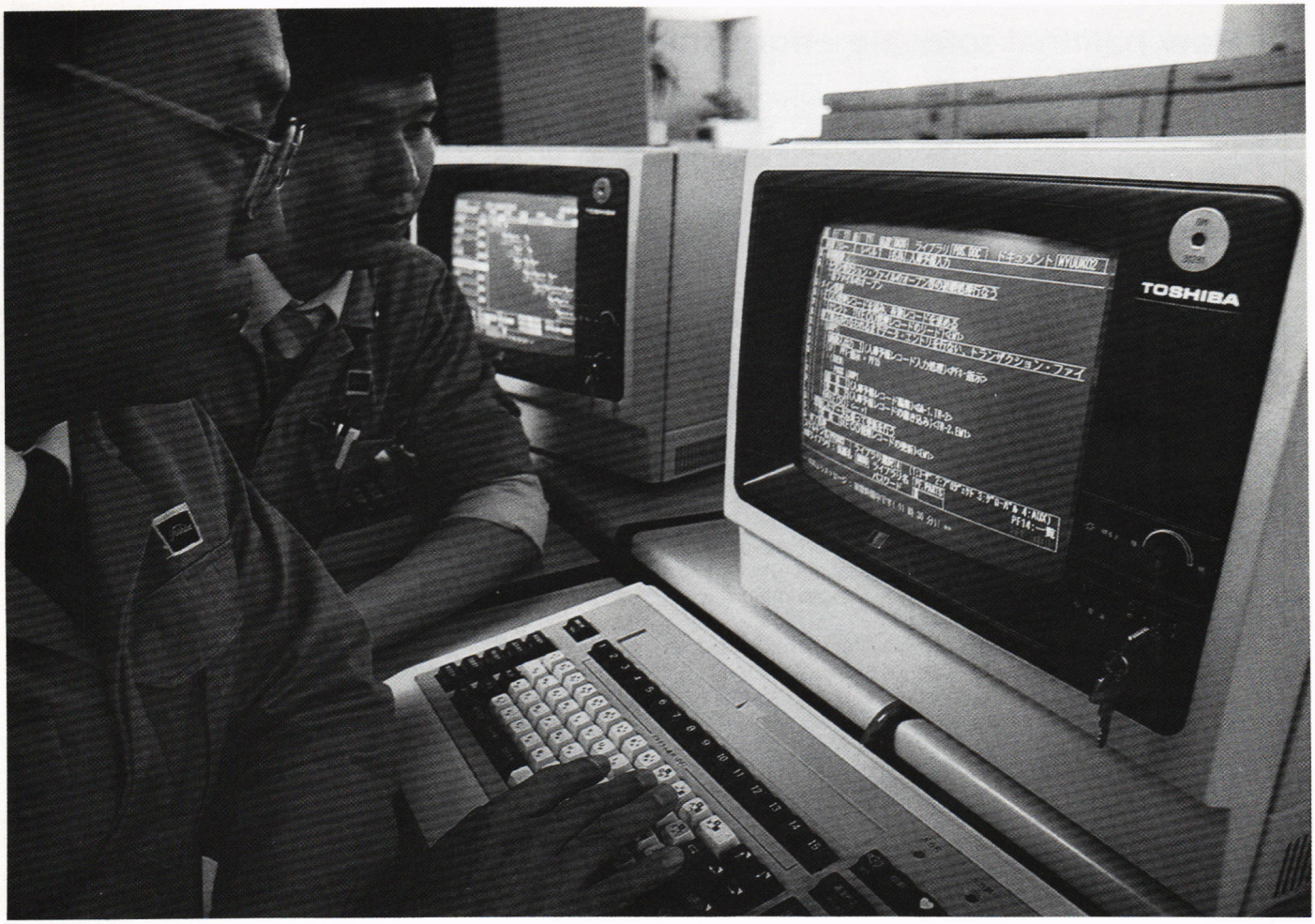
WHEN was the last time you did homework over summer vacation? In Tokyo, Japan the idea is not so strange. Japanese students are brought up in a school system that is very different from the U.S. system. School is more disciplined, more group oriented, and very demanding in Japan.

One cannot help but wonder if this is part of the reason for Japan's great success in the world's technological markets. Japan's leadership in major industries such as semiconductors, and software (an area where they were previously weak), stands out as proof to the fact that they must be doing something right.

An interview with a Japanese student at George Washington University, Yuko Kaneko, gives us insight into Japanese culture and educational traditions that might help find the key to Japan's up-and-coming leadership in modern technology.

IT'S HIP TO BE IN CHIPS

The semiconductor industry is a good example of an industry where Japan is coming out on top. The prediction is that Japan will displace the U.S. for the first time as the world's largest supplier of memory chips. Currently, Japan and the U.S. each hold about 44 percent of the world market. Japan is the major 64K-byte memory chip



No it's not Assembly language, and it's not Fortran, it's Japanese! Production is high as Japanese software specialists work at Sigma project work stations. Courtesy of High Technology.

producer, and their technological lead seems to widening as they produce 256K and 1Megabyte chips, which can hold millions of pieces of data. These chips are built in state of the art fabrication facilities, which are said to have the "cleanest clean rooms." This enables them to have the highest yield of usable chips from a silicon wafer.

SMOOTHING THE ROUGH SPOTS

Japan, instead of ignoring it's technological weaknesses, picks out the troubled areas and concentrates even harder in those fields, in order to catch up. For example, they are making a number of major advancements in the software industry, an area in which they were formerly behind.

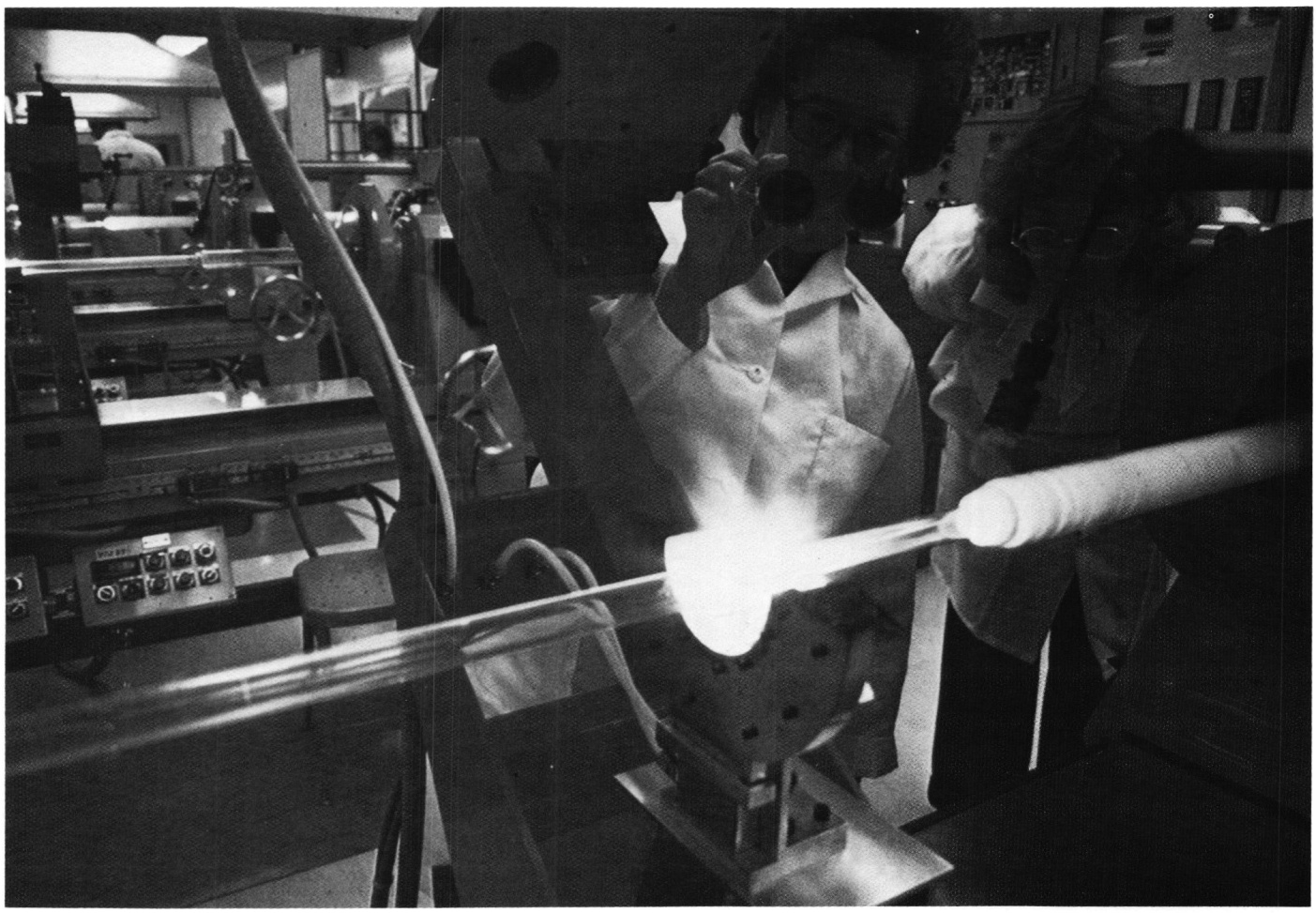
The software industry was traditionally weak because of the language barrier that separates Japan from the Western world. Japanese electronics firms achieved world supremacy over the past quarter century because they used western sounding labels, and dials and switches in English. Japanese buyers adapted to this, and today it is unusual to see goods with Japanese labels in Japanese stores. Japan had to chose between home market and English, so Japan lagged behind U.S. makers in PC hardware and software. But now Japan has perfected a computer system that writes in Japanese. It is called **Sharp WD-80B wah-puro**, which is Japanese for word processor.

The machine can be applied in other countries that use non-Roman characters, such as Arabic, Cyrillic, and Chinese. It could be the best computer on the market for foreign language applications. It was a big challenge because the Japanese language uses tens of thousands of different characters. Seven thousand of the characters are employed regularly in business operations. What is the solution, a keyboard with 7,000 keys?

The problem was solved with a ROM(Read Only Memory) chip, which converts from a phonetic alphabet to the appropriate Kanji character. Each phonetic word has a dozen different meanings, each with its own character. In addition, this amazing machine can print on postcard to legal-size paper in Roman letters, Japanese Kanji, Chinese characters, or any combination of the above. It prints vertically or horizontally and has a built-in graphics capability.

NATIONAL SIGMA PROJECT—SOFTWARE "JAPANESE STYLE"

Another exciting Japanese advance in the software industry is the National Sigma Project, which forms the heart of the nation's software push to build a strong competitive edge for Japan's computer industry. It was begun in 1985 and is a five-year effort, funded with 150 million from the government and almost as much



Japan isn't only grabbing the lead in major electronic areas and semiconductors. They are starting to edge into the more eclectic industries, for example, ceramics manufacturing (shown here). Courtesy of Ceramic Industries.

from Japanese software firms.

The Sigma team "hopes to do what no other nation has achieved"; absolute compatibility Japanese software that can run interchangeably on any Japanese computer. "Sigma is better organized than any other national effort, involving cooperation between hardware and software developers, the government, and computer users," says a Sharp engineer who works with the Sigma group. In the U.S., software efforts are largely uncoordinated; the closest to what Japan is doing is the Defense Department's Ada Software Program.

The cultural setting in Japan seems to favor a more factory-like approach than that practiced in the U.S.. Discipline and adherence to rigid software engineering practices are common in Japan, making the climate for automated programming more favorable than it might be in a more "free-wheeling " setting. The difference in production is obvious in statistics: each programmer puts out 2000 lines of code per month, several times the productivity rate in the U.S..

ALL FOR ONE AND ONE FOR ALL

There is a difference between American and Japanese plants that does not come right out on the surface and stare you in the face, but it's there. This is illustrated clearly by a report on a Japanese auto plant (Mazda) by American workers.

A very productive idea that is ingrained in the minds of Japanese workers is "Kaizen". This means "a worker's commitment to finding ways to do his job better and more efficiently." This is quite unlike the American tradition of separation between the planner and the person responsible for doing the job.

IS EDUCATION THE SECRET TO BETTER WORKER EFFICIENCY?

What *is* the secret that gives Japanese industry that extra edge? Is it customs and ways of thinking deeply ingrained in Japanese children from kindergarten on to high school? I spoke with Yuko Kaneko, a student at George Washington University, who was born and went to school in Tokyo, Japan. She attended school in Japan until her last year of high school, when she moved to the U.S.. I spoke with her to try to gain some insight into the customs and traditions of Japanese schooling.

EULER V. UY

A long summer vacation is now enjoyed by Yuko Kaneko, a George Washington University student. Her former home was Tokyo, Japan.

Kaneko was lucky enough to go to a private school; most public schools in Japan have six day weeks. The students attend school from 8:30 am to 5:00 pm weekdays, and 8:30 am to 12:25 Saturdays. And as if this wasn't bad enough, Kaneko said their school year lasts from April to March, leaving a mere month for summer break. If you're not gasping from oxygen depletion at the thought of an eleven month school year, you will be, because it gets worse. The students must do homework over their little dribbling month of summer break.

Have you ever thought of joining the military? Well, a Japanese high school is not far from it. Even public school students must wear uniforms according to Kaneko, including regulation hair cuts. Kaneko told me that at her school, if a student did not have their bangs cut above their eyebrows, a teacher could chop it off for them.

The Japanese high school could also be compared to American colleges in that the students must choose majors and plan their class schedules accordingly. For instance, if one decided to major in engineering in high school, they would take a lot more advanced math classes than someone who decided to major in social sciences.

In what would be the 11th grade in the U.S., Kaneko took 15 classes, a very large load compared to the 7 or 8 common in American high schools.

When asked to contrast general attitudes of Japanese students with American students Kaneko emphasized the stress on "group" in Japanese schools, compared to the more individualistic attitude in the United States. She believed that this feeling of "being part of a group" started in the earliest years of childhood, when Japanese children are taught how to act and think in a group. This is further reinforced, Kaneko felt, in high school, where students have a homeroom where they are based, and the teachers move around. This gives the students a much more static, group-enforced setting than in American high schools, where students continuously move from classroom to classroom, with different classmates in each room. The team spirit is also allowed to grow and develop in extracurricular sports and activities, of which a student picks a single one and concentrates solely on it, giving his value as a member of the team more meaning. The student is no longer just an individual working for his own gain.

These ideas naturally carry over to the workplace, where the Japanese worker's main concern is with the advancement of the company, not his own. The individualistic attitude of Americans causes a lot of problems in team projects, when people are unwilling to cooperate or consider other's ideas. Has the American ideal of individualism been carried too far? Are we unable to function efficiently in a cooperative environment because of our "my idea is the best" attitude? I think we can learn a lot from our Japanese counterparts. Maybe a mixture of creative individualism and cooperative effort is the key to getting ahead for American engineers of the future. ■

Purchase of ADEPT Machine Strengthens

by Armen A. Sahagian

GEORGE Washington University has leaped to the forefront of production automation and quality assurance with the arrival of the Adept One Robotic System. Although long overdue, the robot has found a fond spot in Thompkins Hall under the supervision of Dr. Bruce Kramer, a professor in the University's Mechanical Engineering Department.

Under Dr. Kramer's guidance, students taking ME 252—Projects in Integrated Design—will have the rare opportunity in creating and executing programs by the Adept Robot in areas such as circular interpolatory motion, micro-chip failure recognition, and precision finishing of jet engine parts. The most promising project in terms of realistic applications is the automation of cancer research equipment and data processing at the National Institutes of Health (NIH) in Bethesda, where Dr. Kramer and twelve students will assist two NIH doctors—Dr. Alfred Feldman and Dr. William Milne—in this endeavor.

The Adept One Manipulator System consists of a four-axis robotic system designed for production applicaitons in light material handling, parts fitting, assembly, and packaging. The system has been expanded to include a vision system. The Adept robot was designed for mean-time-between failures of a minimum of 2,000 hours. According to the Robot Institute of America, a robot is a "reprogrammable multi-functional manipulator."

CONSTRUCTION OF THE ADEPT ROBOT

The Adept robot system is made up of three main parts: a control system, a measuring and servo system, and a mechanical system (i.e. the manipulator). See the included schematic for the layout of Adept's main components with various peripherals.

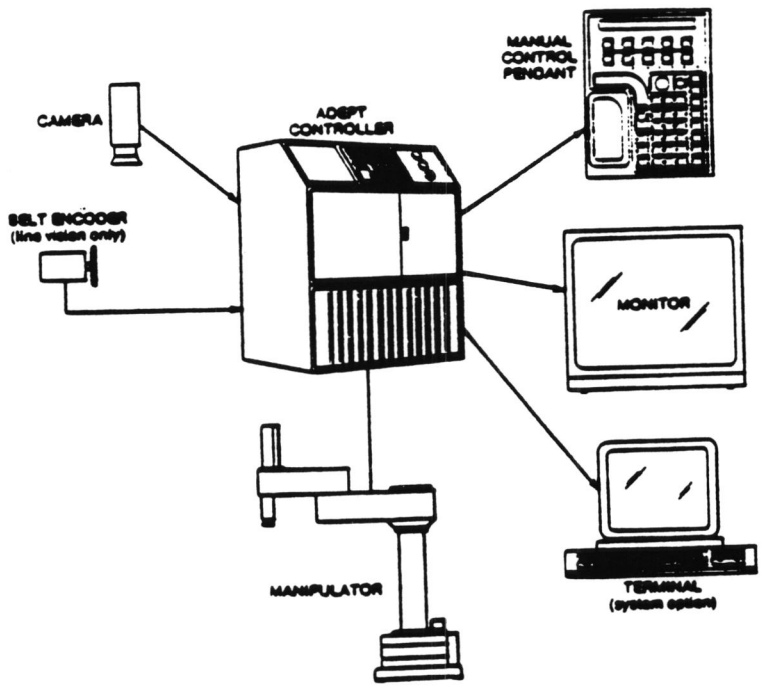
Adept's controller performs as many as three functions: (1) storing, sequencing, and positioning of data in memory; (2) initiating and stopping the motions of the manipulator at given points; and (3) interacting with the external environment. The controller has two basic components, the hardware (i.e. computers) and the software (i.e. utility and task programs). The software accesses an input program (i.e. data describing a sequence of movements for the task at hand), processes the data, and triggers electrical signals that rompt mechanical actions to achieve specific motions required to perform a task. Programming is accomplished by (1) manually installing a program, (2) physically leading the robot through a sequence of motins (i.e. painting the robot), or (3) using machine input controls, via a teach pendant or a computer terminal. We will be relying on the latter mode of programming when it comes to robotic movement.

The measuring and servo system include servo amplifiers, DC motors, and pneumatic pressure regulators. Position regulation is accomplished by means of decoding circuits and a position regulator.

The manipulator is cylindrical in shape and rests on a steel stationary base. Within the manipulator are the mechanical parts—the links, powered joints, end-effectors, and elements—that execute the robot's movements. The manipulator is powered by DC electric motors and pneumatic regulators that require specialized high-precision valves to control the flow of air. End-effectors are devices that pick up, grasp, or otherwise handle objects for transfer or while being processed. They come in all types and sizes. Many must be custom made to match special handling requirements. Grippers are the most universal of all end-effectors.

DESCRIPTION OF MOTION

The Adept system is composed of two horizontally extendable arms, a vertical pneumatic arm,



The ADEPT Robot System consists of three main parts: a control system, a measuring and servo system, and a mechanical system. They are laid out with various peripherals, as shown in this diagram. Courtesy of ADEPT Technology, Inc.

Robotics at GWU

and the central pole on which it is mounted. The arms can move horizontally out from the pole, swivel around it, and the pneumatic arm can move vertically up and down along with wrist rotation.

The electric motors along with pneumatic regulators govern the various joints (or axes) fo the robot. Sometimes, the robot's axes are referred to as "degrees of freedom" (DOF). Our system has four (4) degrees of freedom which are two horizontally extendable arms (i.e. each arm has one DOF), and a vertical arm (i.e. one DOF for up/down motion and one DOF for rotation of wrist at end of this arm).

The drive unit for the rotary motion is rigidly mounted on the pedestal within the central pole, and this drives the body around the pedestal column through a reduction gearbox. It is very difficult to maintain a low ratio since 200 foot-pounds of torque is being generated at the manipulator's base.

VISION SYSTEM

Adept's vision system has an input device w's vision system has an input device which is a vidicon camera. The input video signal has been digitized so the signal can be transferred to the computer as an image. A computer must treat the visual image as an array of brightness dots called picture elements, or pixels. Applications include inspecting critical part dimensions, position measurement or alignment, gap location and measurement, seam tracking, defect detection, and acceptance testing.

ROBOT SAFETY

Safety is an important concern of all individuals within the robot work-cell. A few robot safety objectives to keep in mind are providing a safe working condition, ensuring the integrity and safety of the robot to prevent damage to itself or objects that it manipulates; and use of proper robotic transducers to maintain proper safety requirements. Safety requirements should include fail-safe systems and robot intervention only by authroized personnel.

Fail-safe systems require emergency cutoff devices, including robotic transducers. Ther emergency cutoff device should creep speed without drive energy. During a power failure, the system should have adequate braking abilities and a non-automatic restart.

The age of artificial intelligence arrived this fall, at GWU, with the addition of the ADEPT robot system. ADEPT is fitting name, as it has many capabilities, including a vision system, the ability to assemble, package, and handle light materials.

SUMMARY

The robot is primarily a manipulator-controlled device with software, and, without software, it would be just another machine. In most applications, the software controls the arm that requires precise fixturing or placement of the parts worked on. As the tasks become more challenging, the software concepts will have to become more sophisticated. This means that the programs will have to access some database of its surroundings and make judgements based on that information.

Vision will play an important role in freeing the robot from its dependence on support equipment. It will add a whole new dimension to robotics by using solid-state TV cameras and computers.

Computer-aided design (CAD), along with computer-aided manufacturing (CAM), are growing in use in the robotics field. At George Washington University, we hope to connect the Adept to our IBM system running a program called "CATA." Jeff Winnborne, a senior mechanical engineering student at the University, is paving the way for the interface between "CATA" and the Adept One Robot.

The Adept system is best suited for applications such as machine tool loading and unloading, parts transfer, small parts assembly, electronic assembly and packaging, and printed circuit assembly. The benefits resulting from the appropriate application of robot technology include some of the following: increased productivity, improved product quality, and precision. Robots will significantly alter manufacturing in the near future. ■

US and Japan Battle

by Beatrice Kovel

THERE'S a race on and Japan is winning it. The race is the competition for the first, newest, and best in advanced ceramic engineering. Ceramics may be a lesser known field of engineering, but it is rapidly becoming the direction of the future for car engines, IC packages, substrates and optical devices. The U.S. was the world leader when the transistor and integrated circuit were first developed. Today, that lead has been lost, and the electronic component field belongs to Japan. But recent advances in Japan have jolted the U.S. awake. The U.S. and Japan are now running a close race for the ceramic championship.

Ceramics, by definition, are inorganic, non-metallic materials that are processed at high temperatures. These materials can be prepared and altered on both the microscopic and macroscopic levels to produce physical characteristics different from those of metals and of polymers (plastics).

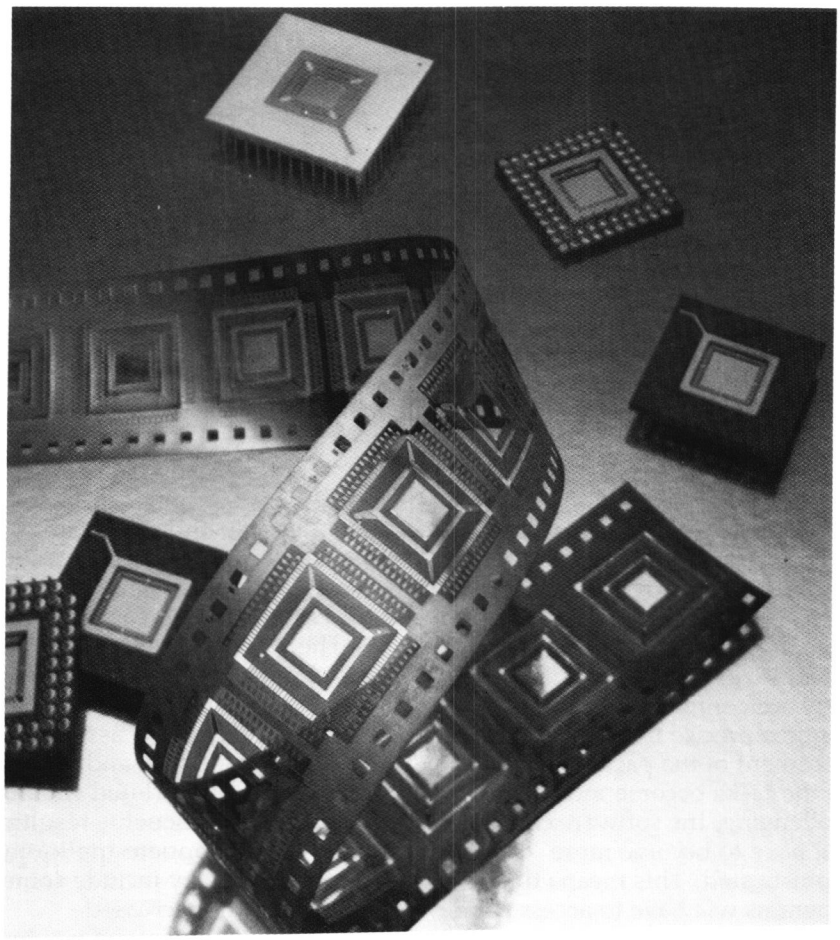
Some aspects of the ceramic field are already familiar to us, not only as engineers, but as everyday people as well. We drive turbo-charged cars with ceramic turbines. Electricity is conducted safely to our homes by the use of ceramic insulators. Some hi-fi equipment has ceramic tweeters. We prepare our meals in ceramic cookware and serve it on china made of fine ceramics. Even mot bathroom facilities are made of fine ceramics!

The technical world is hailing the adaptability of ceramics and their many unique properties. Ceramics are very hard and are resistant to high heat and wear. They have good electrical properties such as high piezoelectric coupling coefficients, fast ion conduction, high magnetic permeability, and changeable dielectric constants. Some exhibit special optical properties that include transparency. Ceramics have low weight per volume, are non-corrosive, and are strong under compression.

Advanced ceramic engineering is showing up in all types of components and devices. The hottest news is, of course, the ceramic engine for auto and industrial use. Why the race for a ceramic engine? For starters, a study conducted by Kent Bowen, Ford professor of engineering at MIT, in 1984, showed the market potential for an advanced ceramic engine was 15 billion dollars. This is the same amount of all the IC and semiconducting industries combined.

A ceramic engine can be operated at much higher temperatures than a conventional engine. The increased combustion will result in a higher efficiency. It does not require any cooling and will be lighter. These results are a reduction in operating costs and improved fuel economy. Ceramics are wear and corrosion resistant, so replacement parts are not necessary. Ceramic components also require less clearance then metal ones, so leakage will be reduced.

Sounds great, doesn't it? Then why don't we have ceramic engines, yet? The U.S. and Japan are working on it, but a few design barriers still need to be hurdled. Reliability is a big problem and very fine powders are required to reduce any flaws. As ceramics are brittle, they cannot be deformed after shaping as metals can, and are difficult to machine. They are much more sensitive to stress concentrations as well. Ceramics fail catastrophically at maximum loading, unlike metals which retain their load carrying



Don't bring out the popcorn, this is not a film reel. It is new innovative packaging for ceramic pin-grid array chips for VLSI circuits. Courtesy of Ceramic Industry.

for Dominance in Ceramics

capabilities. These factors add up to make laboratory results hard to reproduce in manufacturing environments.

Despite these problems, many advances are being made in the ceramic engine, with neither the U.S. or Japan ahead, yet. The American Ceramic Society Bulletin reported that "the U.S. is considered to be leading in basic research and in engine component testing. Japan probably leads in zirconia-based ceramics and in more focused research directed towards early commercialization of products."

In U.S. research, GE has tested a Sterling engine with ceramic hot parts and found a 10 - 26 percent in efficiency over a conventional engine. The projection to the year 2000 showed a 25 - 46 percent increase in efficiency. GM has demonstrated a ceramic-lined diesel engine. Detroit Diesel Alliance has been awarded a contract for the development of an adiabatic diesel engine. They have been testing a radial-inflow ceramic turbine rotor as well. NASA - Lewis Research Center has a patent for a composite piston for an internal combustion engine. The low clearance eliminates the need for rings. NASA - Lewis is also making strides in ceramic seals.

Japanese engineers have projected a 1988 test drive of an all-ceramic engine and by 1990, ceramic-lined diesel. Nissan Motor Co. produced the first car with a ceramic turbocharger rotor for the Japanese domestic market. No failures were reported in the first 3200 cars sold. Isuzu had in 1984 a diesel engine with Zirconia wear parts and in 1985, ceramic glow plugs and a pre-combustion chamber. The company expects that by 1990, it will have a combustion chamber, piston rings, and valves made of ceramic. Projections for the engine show that it will be 14 percent lighter, as there is no need for a radiator or starter motor, and that the turbocharger will be 30 percent more efficient. Mazda is planning a diesel engine with a ceramic swirl chamber. The emission levels are well within the U.S. standards for 1987. Hino Motor Co. has determined that an engine of 30 - 50 percent ceramic is the best for power output and efficiency. The company is working on a 40 percent ceramic diesel engine with all high-temperature components made of ceramic.

This race for the ceramic engine has high stakes. The winning nation will benefit tremendously. The national trade balance will be improved as more cars can be exported and fewer imported. More jobs will be created. The domestic market will be filled with fuel efficient cars, and this will decrease the national dependence on foreign fuel sources. These will add to the 15 billion dollar market to put that nation in the winner's seat.

THE ceramic engine may be the most popular news, but the biggest ceramic market is for electrical applications. Here the race is just as close. Electrical ceramic applications are being found in lasers, sensors, optics, capacitors, and integrated circuits. These components are being used in such systems as controls, computers and telecommunications. The component field is split evenly between the U.S. and Japan. Multilayer capacitors are the real workhorses of the past ceramic industry, and the U.S. is holding its own here. In substrates and electrolyte materials, the U.S. have the edge in worldwide producers. Ceramics have been found to be excellent integrated circuit packages, due to their high insulation properties. The U.S. has pretty much lost this market, which is expected to show the most growth in the future. Japan also dominates the market in pure fine powders that are used in the preparation of the advanced products.

In the optics area, the U.S. is competitive with Japan. Modulators and harmonic generators are using ceramics. Ultra-low-loss fibers are being used in Japan. The U.S. is developing connectors of alumina porcelain that are far superior in reducing alignment mismatches than the plastic connectors used presently. The area of optics still has some technical barriers, but the advantages of lower cost and increased system performance make this an attractive area for research.

Specification checks are an important part of quality insurance at Zircar Products Inc., a producer of a broad range of ceramic products. Courtesy of Zircar Products.

In the area of ceramic sensors, the piezoresistive pressure sensor and the mass spectrometer are causing big news. The mass spectrometer is being used to check engine combustion gases. They are also being used as gas detectors. The Japanese do not add a scent to natural gas and the spectrometer will indicate any leaks. The U.S. is catching up in this area and lower cost sensors are on the horizon.

In Japan, there are several additional projects involving piezoelectronic and electrostructure activators. Examples include a deformable mirror that can be used to control the phase of a light wave. An ultrasonic surgical knife is being developed. A prototype impact dot matrix printer is being tested,

and it has many advantages over an electromagnetic one. It is an order of magnitude faster, uses an order of magnitude less energy, and the heatless drive allows for sound shielding, resulting in no noise.

In other areas of application, the U.S. is developing cutting tools of ceramic. It is ahead in the area of armour and military applications. The Department of Energy is investigating a ceramic fuel cell for electricity and heat production. The National Bureau of Standards has derived cements for root canal fillings and for joint prosthetics.

In Japan, perpendicular magnetic recording is taking off. Ceramic circuit boards are under investigation, and work on ceramic-metal joint seals is progressing rapidly. Perhaps the most unusual use of ceramics comes from Misawa Homes. The company is producing a prefabricated ceramic house complete with doors, windows, wiring and plumbing.

An assessment of the competitive situation studied by the U.S. Department of Commerce stated, "At the present time, there is no clear indication that neither Japan or the US has a general technological lead over the other." When the advanced ceramic parts reach the market, they will be judged based on quality per competitive price. Reliability is based on R&D, a long and expensive process. The U.S. hold the lead in basic research and technology. But in Japan, there is more R&D in conjunction with the government, and their past record for long-term product market development combines to put Japan in a very good position indeed.

Although the U.S. is leading in research, Japan is, overall, slightly ahead in the commercial sense. They have a rapid technology transfer from laboratory to the manufacturer. Japan concentrates on improving processing and optimizing existing technology in order to spread commercialization of new products. The U.S. may fine its extra research will pay off in the long run, but it must gear up now or the entire market will belong to Japan.

As of 1985, the U.S. was not far behind Japan, but if both countries maintain their present approaches, Japan will come out the big winner. The japanese approach to technical advances is an innovative approach to create a market for the products. The assessment also mentioned, "Japan is committed to the commercial development of advanced engineering ceramics as a matter of national policy." The overall push to develop new products and technology has the increasing support of the Japanese government. Japan also uses horizontal integration, meaning that in a large company, many different products may come off of the same assembly line, and large companies produce ceramics for many different application areas. Japan has an aggressive approach when seeking commercialization, and produces a lot of low technology items, like scissors, fish hooks, and pen tips to integrate ceramics quickly into everyday life.

In comparison, the U.S. has a market driven approach and bases its technological paths on the results of market studies. This is due mainly to the free enterprise type of system and the lack of government supported research programs. This type of approach can and will cause delays in advancements. In the case of the ceramic engine, many companies are not starting full-fledged research programs until the market is ready once again for fuel efficient engines. Obviously, research is not instantaneous and this puts the U.S. behind, even before it gets out of the starting blocks.

The U.S. will have to start moving faster to catch up with Japan. The assessment also discussed, "The principle movement for industry action at this time comes from those market analyses that show strong growth for advanced ceramics and the assessments that the industry will continue to be dominated by Japan because of present market positions for electronic ceramic products and the Japanese government incentives in all other areas of advanced ceramic product development." The reluctance of the present administration to support basic research (other than SDI) plays a large role in the trend of not developing new technology. From a defense standpoint, this is extremely dangerous, as the U.S. must import many ordinary devices.

As reported in the January 1986 Bulletin of the American Ceramic Society, the U.S. is starting to pick up the pace. The fact that 50 percent of the ceramics we import comes from Japan, coupled with our trade deficit, is causing some response. Many proposals to try and regain the seminconductor industry, and other electrical ceramics, are being put to both private industry and to the government.

If the U.S. wants to regain and maintain its position as a world leader, it had better pick up the pace now. The federal money for R&D of advanced ceramics must

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EULER V. UY

The ceramic industry is expanding its horizons to include many new products: engines, IC chips, and even the kitchen sink!

EASCON Award Given to GWU-SEAS Student

The annual EASCON award to an outstanding GWU electrical engineering student was won this year by Rober Matikyan. The EASCON prize, which is jointly sponsored by IEEE and the Electronics and Aerospace Society, was given to students from eight other local schools.

EASCON chooses recipients each year from nine local universities. The award is given to "outstanding electrical engineering students. The selection criteria is based on "scholarship, leadership, service to the school and/or community, and contributions to IEEE and other professional organizations or honor societies."

Dr. Richard G. Johnson, Acting Science Advisor to President Reagan, was on hand for the ceremony and congratulated each of the awardees.

—Jeff Winbourne

COURTESY, EE DEPARTMENT

The annual EASCON award, given by IEEE and the Electronics and Aerospace Society, was won this year by Rober Matikyan (right).

SEAS News Briefs

• GWU welcomed the newest member of its staff this fall, the ADEPT II Robot.

• A new lab has been opened in Tompkins Hall: the Computer Integrated Manufacturing and Robotics Laboratory. The center piece is the ADEPT II Robot.

The lab and robot, which are being used for both teaching and research purposes, are already a focus of student attention. Right now, students and faculty are still learning its programming language and its operating controls in preparation for work on design projects.

• The GWU chapter of Omega Rho inducted nineteen members into its ranks. Omega Rho is the Operations Research Honor Society. The new members include graduate students and faculty, as well as undergrads.

• The Engineers' Council is planning Engineers' Week for February 23-28. If you want to work on planning or participate in events, contact the Engineers' Council at D.H. House, 2142 G Street, or call 676-6744.

• Come to DH House! See the new Engineers' Council Toy! What did Santa bring? A $1205 compact disc player. Guess we will all get a lot of use out of that, huh!

—Jeff Winbourne

CMEE Gets New Chairman

After a nationwide search, Raymond R. Fox was appointed chairman of the Civil, Mechanical, and Environmental Engineering Department this past July. Professor Fox had been serving in the position of Acting Chairman for about a year, prior to his appointment. He has been on the faculty at GWU since 1959, 28 years in all.

Professor Fox sees his role as Chairman this way: "Rather than be a leader, I look at myself as being a coordinator of the efforts of a number of spirited people, with great ideas we want to channel in a certain direction."

Regarding graduate teaching assistants, GTAs teaching higher

Continued on page **21**

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Ceramics . . .

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be increased. Governments incentives to promote industrial R&D can only help. The technology transfer from the federal labs to private industry and commercial application must be speeded up. We need to improve our methods of obtaining foreign scientific information and increase our international competition. Educational opportunities and incentives for designing and manufacturing products should be increased. Rapid growth and increased productivity will help to create a market and reduce dependence on foreign supply. This will certainly be worthwhile; to the victor belongs the spoils - a 60 billion dollar market. ■

Plastic . . .

Continued from page **2**
organic compounds in a specific geometric arrangement within the resin.

A well known example of RP is fiberglass. The Japanese use it extensively in molded bath and laundry fixtures, industrial water tanks, machine housings, and sporting goods. Their fiberglass consumption climbed from 16,000 tons in 1965 to 300,000 tons by the end of last year. But, whereas the United States has started integrating RPs in their auto industry, the Japanese still have not. "The U.S. is much more experienced in this area than the Japanese. With our mass production techniques and inexpensive steel, there isn't much incentive to make major changes in that industry.", says Kiyoshi Tabei, director of Toyota's NItto Boseki, a major producer of fiberglass, chemicals and textiles. In the United States, however, RPs have already been used to build the completely plastic body of the Pontiac Fiero.

Though the major part of the Japanese industry sill does not take reinforced plastics seriously, a few companies are pushing it as the new product of tomorrow. Such a company is Nippon Carbon, which is promoting its two-year old Nicalon Silicon Carbide fiber as a reinforcing agent for epoxy resin composites and other engineering materials, including aluminum, ceramic and glass composites. The Nicalon-reinforced epoxy has a very high resistance to impact, and since it is a semi-conductor, it can be used in various electrical applications. This silicon-based material can withstand temperatures up to 1000 degrees centigrade and, when combined with molten aluminum, the material's strength is increased by 60 percent, while its weight is reduced by 40 percent. But the high price tag on this fiber makes it unmarketable for common use, and limits its use to specialized plastic systems.

The major setback of reinforced plastic is that no matter how heat-resistant or impact resistant it may be, it still looks like plastic. And many in the industry still equate the word "plastic" with "substandard." This feeling, though seemingly trivial, has been a strong obstacle to increased use of reinforced plastic. Breakthroughs are now being made to change the surface finish of the RPs and to make it more acceptable.

Though the barriers facing the common use of RPs are large, many feel that they will be overcome and that reinforced plastic will indeed become essential in tomorrow's industry.

—Vaiji Ramaswami

Automation . . .

Continued from page **10**
to differentiate between objects in an assembly line, while a visionless robot's feeders must be redesigned for each new product. Knowing a part's orientation, the robot with vision can execute a series of motions and correct its movements according to information sent from the vision computer.

Force sensors have also been suggested. These contact sensors allow for the precise alignment of workpieces in a machine. A touch-sensitive robot can "feel" around a hole, and attempt to insert a part. A small resistant force means proper insertion. Because of the increased complexity, the addition of sensors slow down a robot. Yet, in the long run, a robot can catch and correct any errors on the spot, thus relieving others to perform time-consuming inspections and repair later on.

The United States and Japan are both industrial leaders, geniuses at advancing technologically, as well as economically. When taking into account all the accomplishments and changes by both nations, one may agree in saying that the United States has a lot to gain from it's chief industrial competitor, yet does not lag too far behind in the race for future world-wide success, in the field of factory automation. ■

CMEE . . .

Continued from page **19**

level courses, Fox pointed out, " For the most part, any GTA's are students at the PhD level. Second, to my knowledge, this is restricted to some Applied Science courses in the sophomore year such as APSC 113." He went on to state, " we also work to ensure, if these are foreign students, that they are proficient in English and, of course, in classroom technique."

He went on to say he has, and will continue to have, an open door policy. "Honest, helpful comments from students are always welcome."

Professor Fox's area of expertise is in structural and foundation engineering.

He is married, has three children, and resides in Bethesda, Md. He also enjoys a day at the links from time to time.

—Jeff Winbourne

EULER V UY

Professor Raymond R. Fox, new chairman of the CMEE Department, sees himself as a "coordinator of the efforts of a number of spirited people (the department's faculty)."

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